We appreciate the Referee's comments below and we have responded to the points in **bold text**.

Referee 2:

The paper uses a general additive model and terrain characteristics derived from remote sensing to map susceptibility of permafrost disturbances (active layer detachment and mud ejection). The GIS-based analysis was successful at identifying important terrain controls at the study site, and the approach seems to have potential for application at other sites. The results are interesting and well executed and the topic is of interest to readers of The Cryosphere, but I'm not convinced The Cryosphere is the most appropriate journal. The paper is quite technical and might be appropriate for a remote sensing journal or for Permafrost and Periglacial Processes, which has a geomorphology focus. An indicator here is that not a single Cryosphere paper was cited. This paper could be made more relevant to The Cryosphere by expanding the discussion to explore consequences for other sites, and by discussing in more depth the physical reasons for the observed explanatory power of the various terrain characteristics.

Response: We thank the reviewer for their comments, but disagree about the appropriateness of the journal. My coauthors and I feel that our paper is highly relevant to The Cryosphere as it presents new research on features that are unique to permafrost landscapes. Mud ejections in particular represent a significant gap in the literature. We have added information to expand the discussion and think that after incorporating the comments from the reviewers it will be suitable for publication in TC. We have made an effort to relate the observations of the features we see at our site to other areas, in particular discussing how PWP results in instability in other regions. We have added more discussion about the terrain variables to Section 5.1 (see specific comments below).

Specific comments

The title, abstract, and beginning of the paper focuses on pore water pressure, but the effect of interest is disturbance. High pore-water pressure is not observable directly, and it's possible to have high pore-water pressure without an ALD or ME. The title and the introduction should be revised to better reflect the topic of the paper - susceptibility to disturbance, not pore-water pressure.

Response: Without high PWP there would be no ALDs or MEs, so we are using the presence of ALDs and MEs as the surface expression of PWP. It is widely accepted in the literature that ALDs and MEs form from high PWP (Washburn, 1956; Shilts, 1978; Zoltai, 1978; French, 2007; Lewkowicz, 2007). We used the presence of ALDs and MEs to predict areas across the landscape that are susceptible to high PWP, and therefore potentially future formation of ALDs and MEs. In this way we feel that the title is appropriate. The introduction has been reworded for clarity.

Some of the observed relationships between the terrain variables make sense physically and some are counterintuitive. For example, why would ALD be more likely in areas of low PISR? Why would ME's be more likely in drier locations and higher elevations? Physical reasons for

all the observed relationships and especially the counterintuitive ones should be explained to convince the reader that those relationships are real and not spurious correlations.

Response: Section 5.1 has been elaborated to explain observed relationships between the high susceptibility zones for ALDs and MEs and the terrain variables.

The probability of observing an ALD approaches 100% for low PISR. This is clearly site-specific and raises concerns about the transferability of the results. Please explain.

Response: Based on our field mapping, modelling and the subsequent terrain analysis we believe that this research identifies a link between PISR and slope disturbance that can't be ruled out without further examination. While this link may not be a direct relationship, PISR may act as a proxy for additional processes associated with ALD initiation. This is not a new observation as evidence of this relation has been noted at other locations and is cited in the manuscript (Leibman, 1995; Huscroft *et al.*, 2004; Lipovsky and Huscroft, 2007; Niu *et al.*, 2014). This relation has also been documented at other sites in the High Arctic through the development of susceptibility models (Rudy et al., 2016a and 2016b). More text has been added to section 5.1 discussing the relation of ALDs to low PISR.

Rainfall is likely to be an important controlling variable. This needs to be discussed, since it is not addressed.

Response: More specific details have been added about the frequency and magnitude of rainfall events, but rainfall wasn't a variable we looked at in this study. Factors impacting PWP are either intrinsic (ex. slope, drainage, solar radiation) or extrinsic (temperature, rainfall) and although extrinsic factors are important, this model only identifies intrinsic factors. Similarly, all areas across the landscape experience relatively homogeneous rainfall, and it is only certain locations which have high PWP, ALDs and MEs due to specific qualities of the landscape at these locations. Therefore, we are using this model to identify these landscape variables. This section of the discussion has been removed, and the text has been reworded to clarify this.

Pg 4 Line 24: what's the basis for the constraints >10 m from water source and > 20m from an ALD?

Response: On average the width of channels at Cape Bounty are less than 10 m, to ensure that randomized points were not placed in a stream a rule of >10 m was selected. Again, to ensure that randomized points were not placed within the boundary of existing ALDs a minimum distance of 20 m was selected. Points were generated using the "Random Point" tool in ArcGIS with the additional criteria (>10 m from a water source and >20 m from an initiation point). The text has been clarified.

Pg 5 Line 4-7: The description of the declustering process is difficult to follow and should be explained more clearly. As I understand it, because closely located features carry redundant information, spatial clusters of features are replaced by representative features.

Response: The reviewer is correct, dense clusters of MEs were removed to avoid redundancy and statistical bias. Declustering was achieved by creating a 10 m buffer zone around each mapped ME feature in ArcGIS, and areas where buffer zones intersected were treated as one large polygon to represent the region of the cluster. A single point representing a ME was randomly generated as a representative point for every 10 clustered points within the polygon (i.e., a cluster of 25 MEs would result in 3 points). This has been reworded in the text for clarification.

Pg 5. Line 4-7. The declustering algorithm seems arbitrary. Are the results sensitive to how that is done?

Response: Analysis was done both with and without declustering, and was more representative of the study area with the declustering as it reduced statistical bias to the landscapes where the clusters were found. Clusters of MEs were mapped as a polygon, and then one point for every 10 MEs within the polygon were randomly generated within the area as a representative point.

Pg 6. Line 21. How were the features partitioned between the calibration and validation subsets? Random?

Response: The total (combined disturbed and undisturbed points) datasets for each MEs and ALDs were randomly subdivided into 70 per cent calibration and 30 per cent validation subsets. The text has been clarified.

Pg 26. Line 1. What is an "explained deviance"?

Response: Relative importance of variables was evaluated by the change in explained deviance from the full model as variables were removed individually. If the variable is important for the model it will result in a higher explained deviance. For example, the slope variable had the greatest explained deviance from the full ALD model. It is the equivalent of R^2 in a linear-regression model. This has been clarified and some references have been added.

Final sentence: The phrase "incentive and potential to move towards: : :" makes for a weak conclusion. Is it not possible to say something more definitive?

Response: This has been reworded.